# PCMDI Support of Coordinated Modeling Activities

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## Overview and Rationale

Model intercomparison projects ("MIP's") consist of common experiments performed by multiple models, which can:

- indicate (by large spread) where models might not be reliable, and indicate (by narrow spread) where model results might be considered more robust
- identify systematic errors across models
- suggest where research should focus
- foster healthy competition across modeling groups
- provide an archive of model output open to scrutiny by a wide community of experts

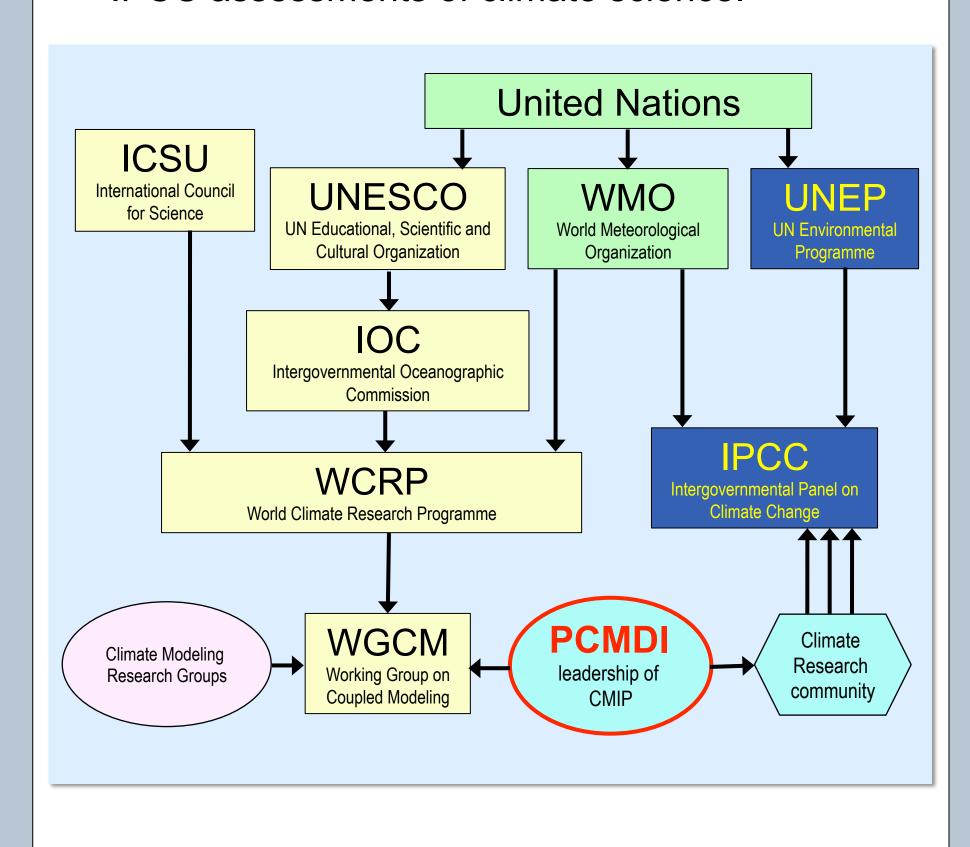Leadership is required to plan, promote, and help manage MIP's.

PCMDI has established itself as model neutral (playing no favorites) and has gained the trust of the international climate modeling community.

From its founding more than 20 years ago, PCMDI has successfully assumed major responsibility for several successful MIP's (e.g., AMIP, CMIP, and PMIP)

The lessons learned and the knowledge gained from this record of success establish PCMDI as the provider of a unique capability in ongoing support of the international climate research community.
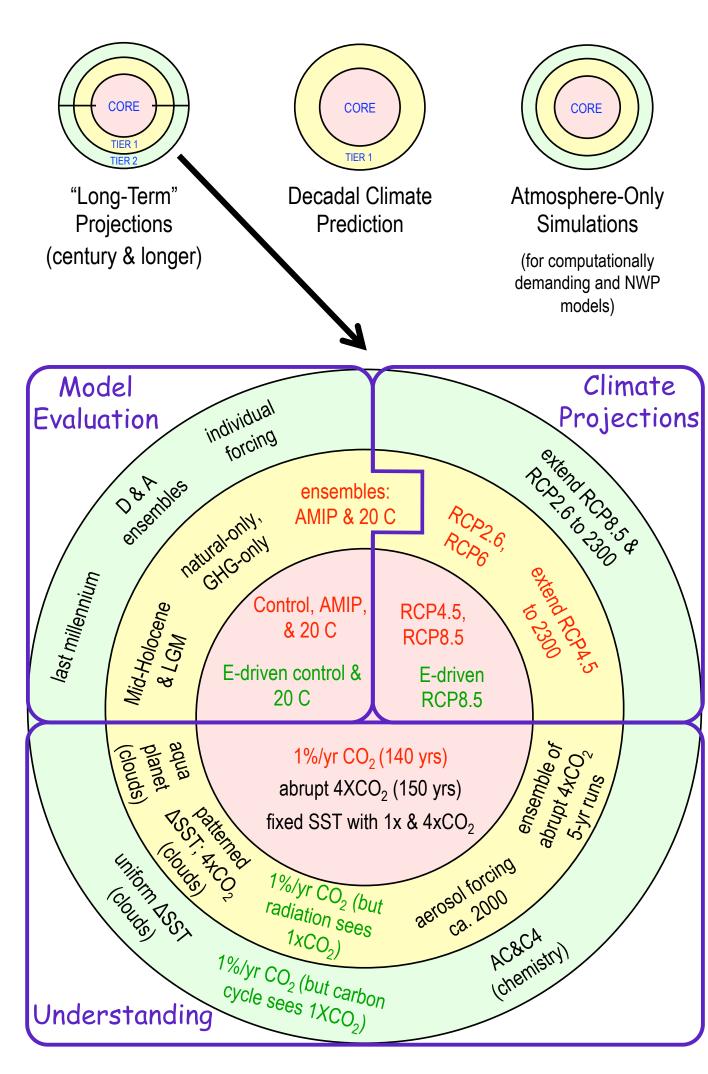
## International Context for PCMDI's CMIP Leadership

Working within the WCRP's organizational framework, PCMDI enables cutting-edge research across the climate science community and has provided key input to IPCC assessments of climate science.



## PCMDI's Major Contributions to MIP's:

### Experiment design:

- PCMDI provided essential leadership in building a consensus among competing constituencies to optimize value of experiments
- CMIP5 integrated the CMIP, AMIP, PMIP, CFMIP, Aqua-Planet projects into a synergistic set of experiments.
- We specified details of experiment protocol and requirements.



"Long-Term" Projections (century & longer)

Decadal Climate Prediction

Atmosphere-Only Simulations (for computationally demanding and NWP models)

Taylor, Stouffer, & Meehl, *BAMS*, 2012.

### Negotiated list of requested model output:
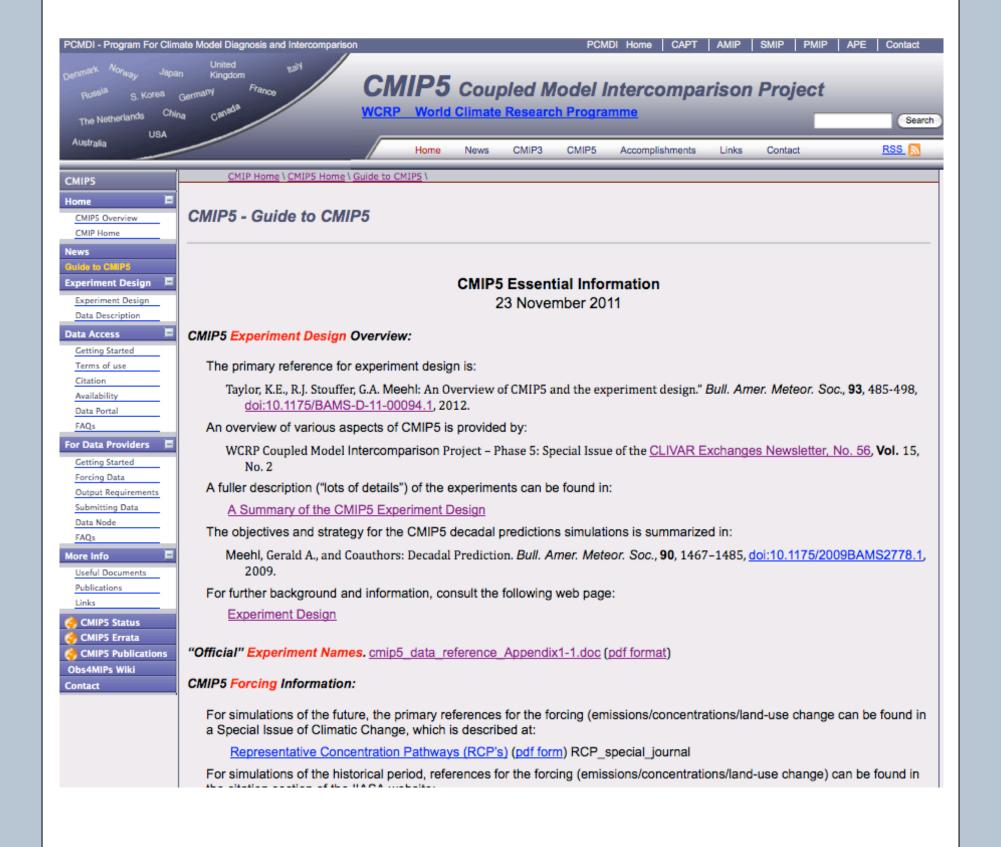
Domains (number of monthly variables*):

Atmosphere (60)
Aerosols (77)
Ocean (69)
Ocean biogeochemistry (74)
Land surface & carbon cycle (58)
Sea ice (38)
Land ice (14)
CFMIP output (~100)

*Not all variables are saved for all experiments and time-periods

Temporal sampling (number of variables*)

Climatology (22)
Annual (57)
Monthly (390)
Daily (53)
6-hourly (6)
3-hourly (23)

See http://cmip-pcmdi.llnl.gov/cmip5/output_req.html

## Comprehensive CMIP5 website:



## Model output archive:

See poster by Dean Williams for details.

- PCMDI pioneered serving data from multi-model ensembles
- Data volumes have expanded from gigabytes to petabytes over a 20-year period
- Number of users has grown from dozens to thousands.
- Besides providing grid access to data, PCMDI leads the world-wide effort to create a distributed archive, providing redundancy and minimizing data transfer from modeling groups to data centers.

## Foundational supporting elements:

A key to the scientific impact of CMIP is that output from all models is served in "self-describing" files adhering to a common structure and format.

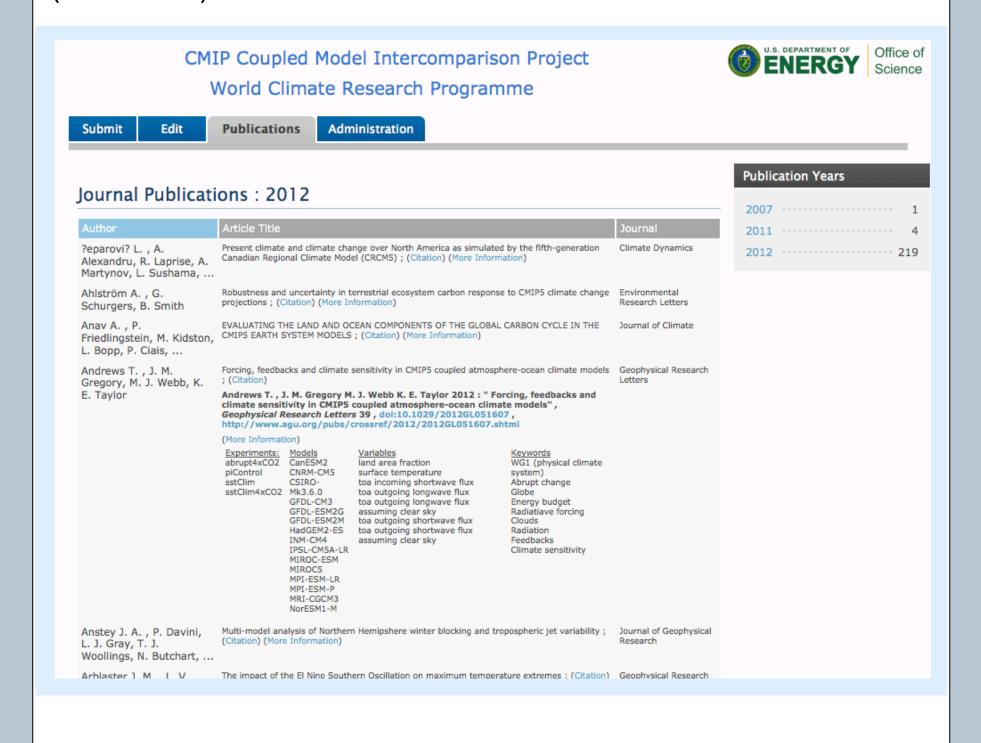PCMDI helped originate and now supports CF-conventions defining the "self-describing" syntax.

- Chairs governance board and key committee
- Maintains website in support of CF

http://cf-pcmdi.llnl.gov/

PCMDI has made available "CMOR" software to write data in compliance with CMIP requirements

- Now relied on by nearly all modeling groups to prepare their output.
- Traps common errors, ensuring more reliable data products.
- Now used by a number of other projects (e.g., CFMIP, geoMIP, TAMIP, ACCMIP, Obs4MIPs)

## Impact and Future Work

PCMDI has enabled publication of >500 journal articles from CMIP3 and in less than a year >200 articles on CMIP5 (submitted)



PCMDI is transferring lessons learned and MIP capabilities to other projects and is collaborating internationally to avoid duplication of effort and ensure compatibility of infrastructures

- Development of standard performance metrics: WCRP Metrics Panel (see poster by Gleckler)
- Community-wide software development in support of climate modeling: GO-ESSP – Global Organization for Earth System Science Portals
- Links from climate modeling community to impacts community: TGICA – IPCC Task Group on Data and Scenario Support for Impact and Climate Analysis
- Development of standard documentation of models and simulations: METAFOR – Common Metadata for Climate Modelling Digital Repositories, ES-Doc, and CURATOR
- Transfer of capabilities to other MIP's: CORDEX, PMIP, CFMIP, GEOMIP, TAMIP…
- Close interaction with European infrastructure development and model evaluation efforts: IS-ENES – InfraStructure for the European Network for Earth System Modelling; EMBRACE

Future plans build on PCMDI's unique experience and scientific leadership:

- Advocate freezing the core CMIP5 experiments to reduce demands from modeling groups
- Foster an expectation that results from core experiments be routinely contributed to CMIP archive for general scrutiny as new models are developed
- Promote standard metrics to quantify improvements in models and provide an overview of model errors
- Expand Obs4MIPs effort to provide observational data in forms that are more amenable to model evaluation.
- Develop common procedures across coordinated modeling activities to minimize effort needed to participate.

## Acknowledgement